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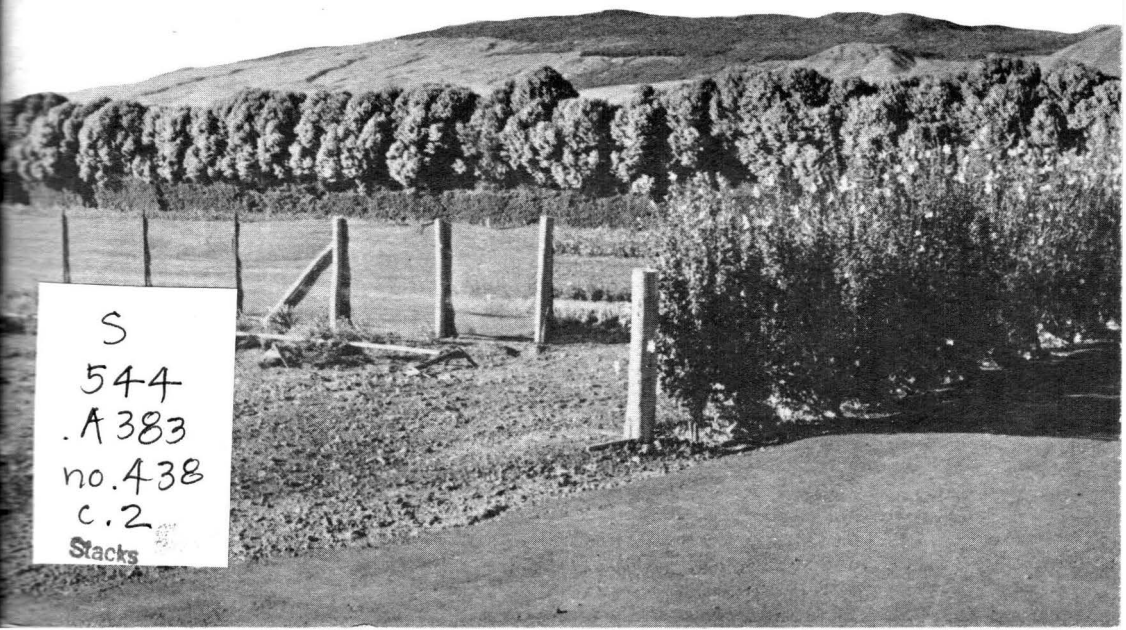
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WINDBREAKS FOR HAWAII

Wade W. McCall, Gordon T. Shigeura,
and Yusuf N. Tamimi



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FOREWORD

Wind is an important factor in agriculture in Hawaii. Much of the knowledge regarding windbreaks is scattered in many different publications. The purpose of this circular is to present the basic theoretical aspects of windbreak use. This is the first of a series of publications on windbreak use in Hawaii. Future publications will present information on planting materials suitable for windbreaks, constructed windbreaks, wind erosion and its control, windbreaks for urban use and other special purposes, and the results of a windbreak survey on present practices in windbreak use in Hawaii.

WINDBREAKS FOR HAWAII

Wade W. McCall, Gordon T. Shigeura, and Yusuf N. Tamimi

Hawaii is in the northern limits of the tropics. Prevailing winds are the northeasterly trades. These winds are due to the presence of a permanent high-pressure belt and are generally 8 to 20 miles per hour; gusts up to 40 miles per hour may also occur. Tradewinds blow for 250 days or more each year. During the absence of the permanent high-pressure belt, it is possible to have winds from an opposite or variable direction at any season but most often in the winter. These winds, often referred to as "Kona" winds, are usually associated with stormy weather and are of higher velocity than the "normal" tradewinds. Gusts up to 80 miles per hour or more may occur, causing considerable damage to agricultural crops. Fortunately, these winds are of short duration and are generally restricted to local areas.

Winds of different velocities have different effects upon soil, crops, animals, and people. Table 1 shows the effect of wind velocity upon soil and plant environment. The actual effect of the wind depends upon the nature of the wind, the crop, climatic factors, and the protection provided. The best protection is one that reduces wind velocities to safe levels. Reduction of wind velocity is provided by barriers that allow more favorable conditions for soil, plant, animal, and human protection and development. Any barrier used to reduce wind velocity and provide more favorable environmental conditions is known as a windbreak.

Table 1. Effect of wind velocity upon soil and plant environment

Wind effect	Wind velocity¹ Miles per hour
Soil movement ²	10 - 15
Reduced pollination ³	10 - 15
Reduced activity of insects	10 - 15
Mechanical damage to plants ⁴	15 - 20
Increase in transpiration and evaporation ⁵	
1	Calm
2.2	5
3.8	10
4.9	15
5.7	20
6.3	30

¹Wind velocity at level of the growing plant.

²Depends upon soil texture and structure. Sandy soils and soils with little or no structure erode at lower velocities.

³Blowing of flowers and pollen. Reduced activity of insects also reduces pollination.

⁴Mechanical damage to plants due to direct effect of wind, i.e., bending over, breaking branches, etc. Soil blowing will also damage plants due to abrasion by soil particles.

⁵Relative values based upon calm conditions.

Purpose of Windbreaks

The primary purpose of a windbreak is to reduce wind velocities to a degree that will provide the necessary protection. Some secondary effects of reducing wind velocity are (1) increased temperature in the protected area, (2) increased humidity and reduced evapo-transpiration in the protected area, (3) reduced dust problems, (4) shelter and food for wildlife, and (5) improved aesthetic value of the area.

Factors to Consider

When establishing windbreaks consider the following factors:

- (1) Nature of crop or area to be protected. How resistant is the crop or area to wind damage? How will the crop be affected by possible shading effects of or competition from planted windbreaks.

- (2) Local soil and climatic conditions of the site. These are important in determining what type of windbreak to use and the care necessary to establish and maintain the windbreak.
- (3) Choice of planted (natural) windbreaks or constructed windbreaks. The type chosen should provide the necessary protection when it is needed. This often involves the use of both types. The constructed windbreak provides "instant" protection and the natural windbreak provides protection as the planted materials attain the proper amount of growth.
- (4) Selection of species adapted to local conditions. Planting material adapted to the soil and climatic conditions of each site must be used. In addition, the species should provide the growth characteristics which provide the necessary protection.
- (5) Location, number of rows, and spacing. In planting windbreaks, the spacing of plants in the row and spacing between rows are important. In constructing windbreaks, the spacing or density is important. Either type should be located and spaced to provide maximum protection to the area under consideration.
- (6) Proper orientation. Windbreaks should be placed crosswise or perpendicular to the direction of prevailing and storm winds. This is the most effective way of reducing wind velocities to safe levels.
- (7) Proper preparation of the site. For planted material, soil preparation, fertilization, and adequate moisture are necessary. For constructed windbreaks, sufficient anchorage is required.
- (8) Proper care and maintenance—replanting, fertilization, protection from livestock, fire and trespassing for planted materials, and protection from livestock and fire for constructed materials. Necessary repairs to constructed materials should be made as the need arises.
- (9) Side benefits or plus factors. The secondary purposes mentioned above should be considered as plus factors of using windbreaks.

When establishing the windbreak, prepare plans far enough in advance so that planting materials, supplies and equipment are available to facilitate establishment at the time desired.

Classification of Windbreaks

Windbreaks may be classified in different ways: permanent (Plate 1) or temporary (Plate 2), planted or constructed, and dense or permeable.

Permanent windbreaks or those used to provide long-term protection generally consist of trees and shrubs that grow to relatively great heights and remain in place for many years. Temporary windbreaks may be fast-growing plants or constructed materials that provide protection over a relatively short period of time. Most plans for windbreaks include a combination of both types to provide maximum protection of the crops grown. Permanent windbreaks may remain more than 100 years, and temporary ones for 10 years or less.

Planted or natural windbreaks are those consisting of living plants and may be used as permanent or temporary windbreaks. Some are tall-growing species and some low-growing; some are relatively slow growing and some fast growing. Many times tall-growing, permanent windbreaks are established between fields, and the fast-growing, shorter species are used as infield windbreaks (Plate 3).



Plate 1. Permanent windbreak consisting of several species of trees [*Macadamia integrifolia*, *Eucalyptus sideroxylon*, *Araucaria excelsa* (Lamb) R. Br., *Eugenia cuminii* (L.) Druce, *Melaleuca leucadendron* (L.)] to insure wind protection even though some species may be adversely affected by disease, insects, or weather.



Plate 2. Temporary windbreak (*Saccharum spontaneum moentai* or wild cane) planted to provide protection over relatively short period of time. Note spacing to keep wind velocity at safe level for plant and soil protection.



Plate 3. Combination of permanent windbreak [*Melaleuca leucadendron* (L.) or paperbark trees] at margin of field and temporary windbreak (*Saccharum spontaneum moentai* or wild cane) in field to provide maximum protection from wind velocities.



Plate 4. Temporary constructed windbreak to provide wind protection for vegetables. This is constructed of saran cloth which has proven to be an excellent material for this purpose. Constructed windbreaks may be of a wide variety of materials other than saran cloth.

Windbreaks may be constructed from a great variety of materials such as plastic (Plate 4), wood, etc. These constructed windbreaks are usually temporary until planted materials grow sufficiently to provide the desired protection.

Dense or solid windbreaks are those that allow little or no wind through them. Permeable windbreaks allow wind through them. Figure 1 shows the effect of a solid windbreak upon wind velocity and pattern. Figure 2 shows the effect of a permeable windbreak.

Windbreak Effects

Windbreaks produce the following effects:

- (1) Reduce wind velocities to the leeward or downwind side of the windbreak 70 to 75 percent up to three times the height of the windbreak, 40 to 50 percent up to ten times the height, and 20 to 30 percent up to twenty times the height (Figure 3). The windbreaks should be spaced so that a minimum of 50 percent reduction of the wind velocity is obtained.
- (2) Reduce evaporation in protected area up to 40 percent of the unprotected area. This conserves soil moisture and reduces the transpiration stress on the plants.

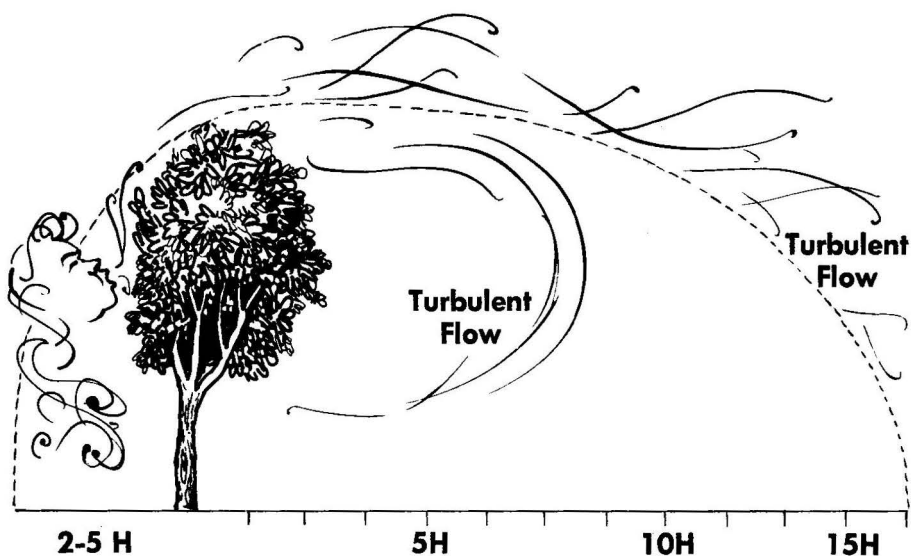


Figure 1. Effect of dense or solid windbreak on wind flow pattern. Note turbulent flow leeward of the windbreak; this may cause plant damage. NOTE: (Vertical effects have been exaggerated to illustrate effect of wind.)

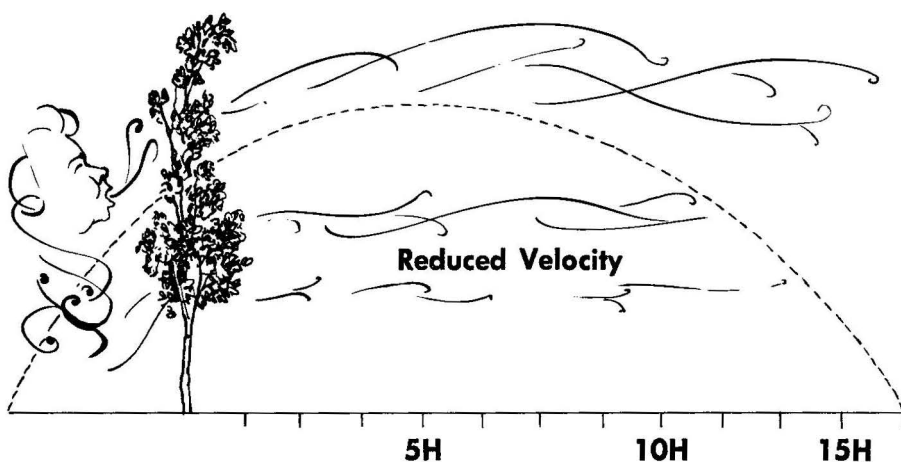


Figure 2. Effect of permeable (65 to 75 percent) windbreak on wind flow pattern. Wind velocities may be 25 to 30 percent higher at the same distance from the windbreak as compared with the dense or solid windbreak. (NOTE: Vertical effects have been exaggerated to illustrate effect of wind.)

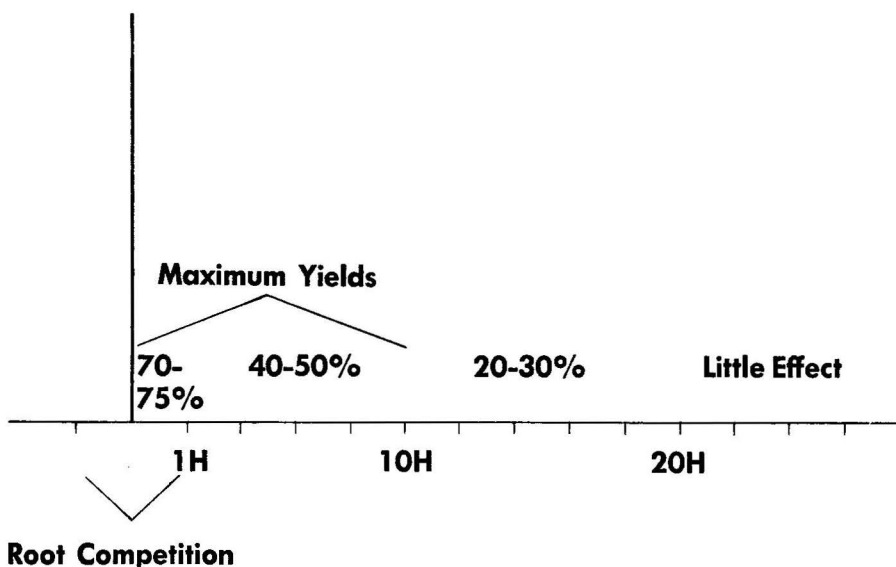


Figure 3. Effect of windbreaks upon wind velocity and crop yields based upon density of 75 to 100 percent. Reduction of 25 percent in density reduces effect from 40 to 50 percent at 10H to 33 to 45 percent at 7H.

- (3) Increase temperatures in the protected areas up to 9° to 10° F.
- (4) Reduce soil erosion. Care should be taken that wind is not channeled through the windbreak so that erosion occurs in the area adjoining the windbreak.
- (5) Reduce mechanical damage to plants. Windbreaks reduce the loss of flowers or fruits due to mechanical effects, reduce abrasion to stems and leaves due to blowing of soil particles against them, and reduce breaking of stems, branches, or other parts of the plant.
- (6) Increase activity of bees and other insects and increase pollination in the protected area. Yields may be increased by 100 percent where wind is a serious problem.
- (7) Compete with crop plants for distance up to 1½ height of the windbreak. This reduces yield in the area. Shading may cause the reduction in yield rather than plant competition for moisture and nutrients.
- (8) Increase certain types of disease due to higher moisture and temperature in the protected area.

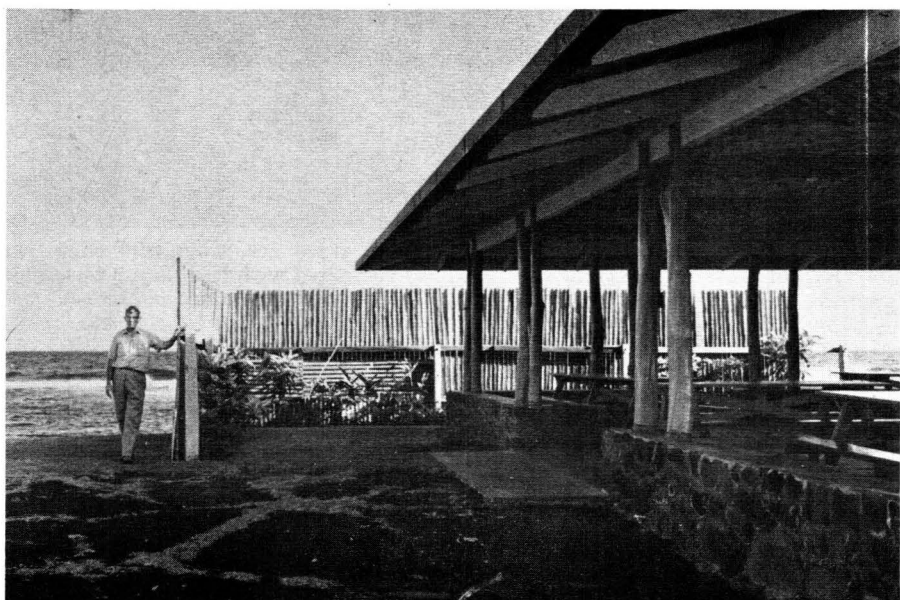
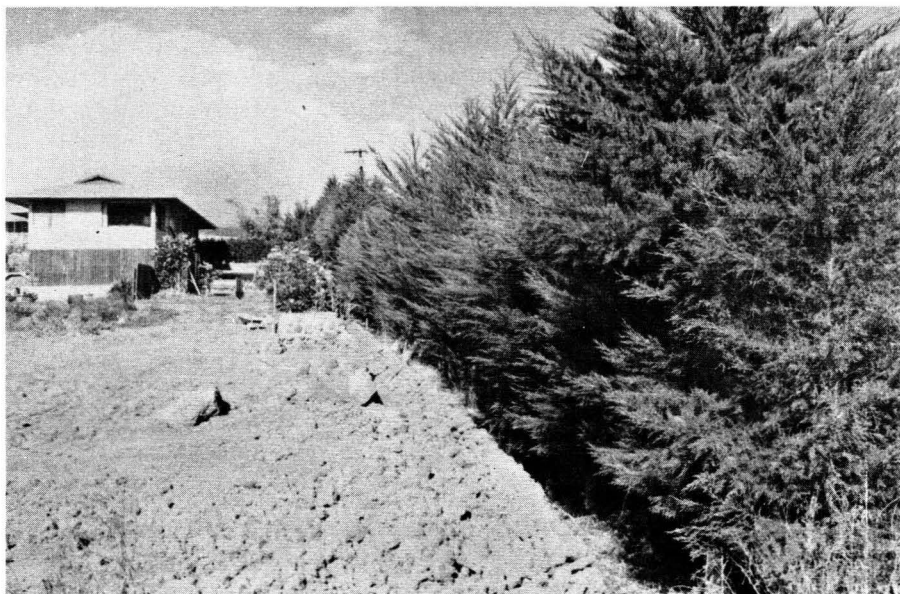


Plate 5. Windbreaks provided to increase comfort to people rather than to protect plants. A. To reduce dust and increase comfort of home with permanent planted windbreak (*Cupressus macrocarpa* Hartweg ex Gordon or Monterey Cypress). B. To provide comfort for those using the pavillion with temporary constructed windbreak.



Plate 6. Windbreaks must be maintained and cared for. This wild cane was uncared for; it is 37 feet from side to side as compared with less than 3 feet. This represents a serious loss of ground space as compared with that in Plate 3.

Where to Get Help

Trees and planting materials may be obtained from the State Tree Nursery, State Division of Forestry, P. O. Box 457, Kamuela, Hawaii 96743, and from most commercial nurseries on all islands.

The Cooperative Extension Service of the University of Hawaii has an office in each county. There are County Extension Agents in each office who can assist you with further information on windbreaks. Please feel free to call upon the agents to help you.

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College of Tropical Agriculture, University of Hawaii, Honolulu, Hawaii 96822
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